

Nature of science
Standard level
Paper 2

Tuesday 2 May 2017 (morning)

Candidate session number

1 hour

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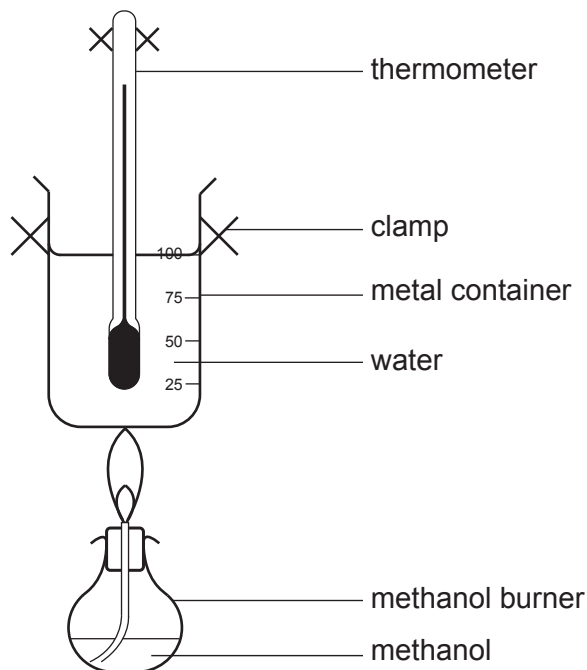
Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[45 marks]**.



Answer **all** questions. Write your answers in the boxes provided.

1. This apparatus was used to provide data to calculate the energy density of methanol. One method of calculating the energy density of a liquid such as methanol is to measure the heat energy transferred to water as the liquid is burned.



The energy transferred to the 100 cm^3 water from the burning methanol can be calculated using the equation:

$$Q = mc\Delta T$$

Q = energy transferred (J)

m = mass of water (g)

c = specific heat capacity of water ($\text{J g}^{-1} \text{ } ^\circ\text{C}^{-1}$)

ΔT = temp change (in $^\circ\text{C}$).

Assume that:

- 1 cm^3 of water has a mass of 1 g
- the specific heat capacity of water $c = 4.18\text{ J g}^{-1} \text{ } ^\circ\text{C}^{-1}$.

(This question continues on the following page)



(Question 1 continued)

Results:

Table 1

Methanol trial no.	Initial temperature of the water / °C	Final temperature of the water / °C	Initial mass of the methanol / g	Final mass of the methanol / g
Trial 1	18	38	189.9	188.0
Trial 2	19	38	188.0	186.0
Trial 3	18	38	188.0	185.9
Trial 4	19	40	188.0	186.1
Trial 5	20	40	188.1	186.0
Trial 6	18	38	188.0	185.9
Trial 7	19	39	188.0	186.1
Trial 8	19	40	188.1	186.1
Trial 9	19	38	188.1	186.1
Trial 10	19	39	188.0	186.0
Mean	19	39	188.2	186.2

- (a) Calculate the mean heat energy transferred to the water by the burning of methanol.
Show your working.

[2]

(This question continues on the following page)



(Question 1 continued)

- (b) The same apparatus provided data to calculate the heat energy transferred to the same mass of water by the burning of ethanol.

Burning 1.5 g of ethanol produced 8275 J. State with a reason which fuel has the highest energy density.

[2]

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- (c) Suggest why the energy density values calculated by this method would be lower than published values of the energy densities.

[3]

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The energy density depends on the number of bonds in each molecule.

- (d) Explain why the energy density of ethanol ($\text{C}_2\text{H}_5\text{OH}$) differs from that of methanol (CH_3OH).

[2]

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(Question 1 continued)

- (e) State **one** energy conversion in the production of an audio telephone message. [1]

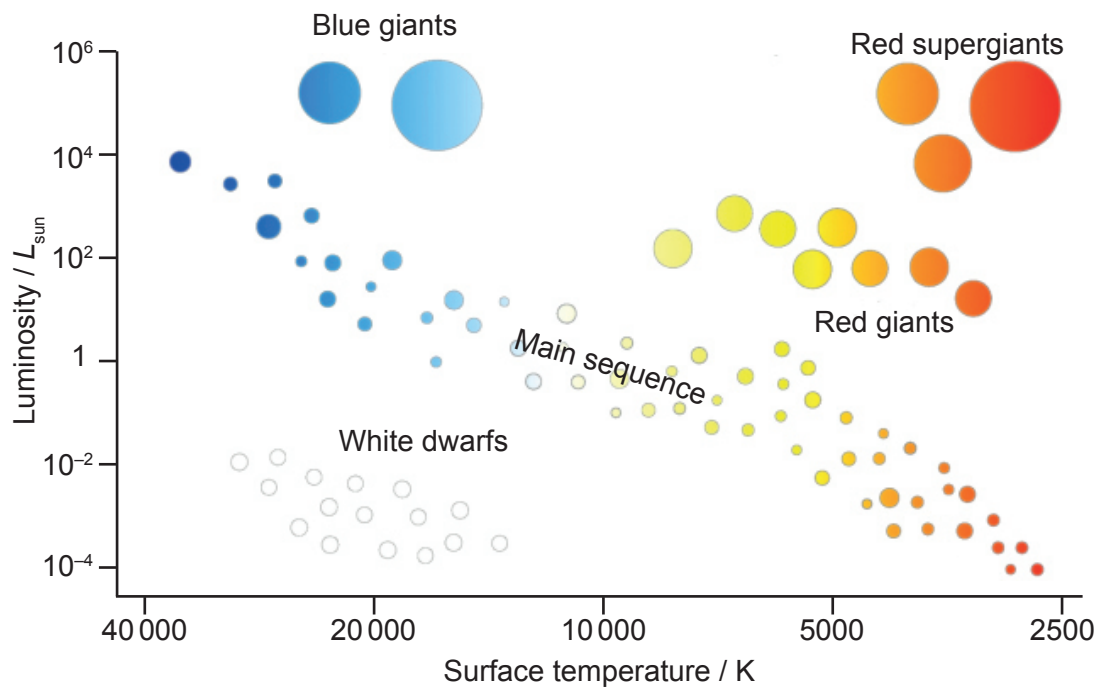
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- (f) Discuss the use of resources in the production of mobile telephones. [2]

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2. The diagram shows the relationship between star luminosity and surface temperature.



[Source: <https://lcogt.net/spacebook>]

- (a) State the name of this diagram.

[1]

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- (b) (i) State the luminosity range of red supergiants.

[1]

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- (ii) Outline the origin and evolution of red supergiants.

[2]

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(Question 2 continued)

- (c) State the relationship between surface temperature and the star's lifetime. [1]

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- (d) Outline **two** reason(s) for the relationship between surface temperature and lifetime in stars. [2]

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- (e) Outline the type of nuclear reaction taking place in our Sun. [2]

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- (f) Explain how stellar spectra can be used to deduce the presence of elements. [2]

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3. Ebola virus disease (EVD) is introduced into a human population through close contact with the body fluids or organs of infected wild animals. EVD spreads through human-to-human transmission via direct contact with the body fluids of infected people and any contaminated materials. The mean EVD fatality rate is around 50 %, but can be as high as 90 %.

- (a) In August 2014, approximately 5800 cases of Ebola virus infection were reported in West Africa. Calculate the number of patients that are likely to die from this infection based on the highest possible fatality rate.

[1]

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- (b) In 2014, Sierra Leone’s government quarantined more than a million people. Discuss the ethical aspects of this action.

[4]

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- (c) Suggest public health policies and practices other than quarantine that would minimize transmission of the virus.

[3]

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(Question 3 continued)

(d) Scientific research suggests that the Ebola virus has only been detected in mammals.

- (i) If people assumed that the arrival of a flock of birds caused an outbreak of EVD, state the name of this type of fallacy of reasoning.

[1]

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- (ii) Define this type of fallacy.

[1]

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- (iii) Describe the process of peer review for publication of a scientific research paper on an EVD vaccine.

[2]

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4. It is claimed that diesel engines emit about 15 % less CO₂ than conventional internal combustion engines. To meet climate change targets, some governments promoted the sale of diesel cars, resulting in an increase of 33 %, to 54 % of total car sales. Both types of engines also emit NO_x gases and particulates (small soot particles, particulate matter 2.5, PM_{2.5}) with diesel engines having bigger emissions. These emissions have various effects on human health.

(a) State the innovation that allowed for the reduction of toxic exhaust gas emissions.

[1]

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(b) Discuss the nature of the evidence required to make a scientifically based decision to promote the sale of diesel cars.

[4]

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The European Union requires that all new cars registered from 2015 onwards do not emit more than 130g of CO₂ per km.

(c) Outline the practical problems a governing body would face to enforce this legislation.

[3]

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(Question 4 continued)

- (d) Suggest reasons why national and regional legislation alone is not sufficient to achieve the scientifically established global CO₂ emissions targets.

[2]

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Answers written on this page
will not be marked.



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